



(11)

EP 3 546 053 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
21.07.2021 Bulletin 2021/29

(51) Int Cl.:
B01D 53/14 (2006.01) **C10K 1/08** (2006.01)
C10K 1/34 (2006.01)

(21) Application number: **17874942.0**(86) International application number:
PCT/JP2017/041514(22) Date of filing: **17.11.2017**(87) International publication number:
WO 2018/097063 (31.05.2018 Gazette 2018/22)

(54) GAS PURIFICATION DEVICE AND GAS PURIFICATION METHOD

GASREINIGUNGSVORRICHTUNG UND GASREINIGUNGSVERFAHREN

DISPOSITIF DE PURIFICATION DE GAZ ET PROCÉDÉ DE PURIFICATION DE GAZ

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(30) Priority: **22.11.2016 JP 2016226753**

(43) Date of publication of application:
02.10.2019 Bulletin 2019/40

(73) Proprietor: **Mitsubishi Heavy Industries
Engineering, Ltd.**
Nishi-ku
Yokohama-shi
Kanagawa 220-8401 (JP)

(72) Inventors:
• **YOSHIDA, Kaori**
Tokyo 108-8215 (JP)

- **HIRAYAMA, Haruaki**
Tokyo 108-8215 (JP)
- **KAN, Rikio**
Hiroshima-shi
Hiroshima 733-0036 (JP)
- **KAKESAKO, Seiji**
Hiroshima-shi
Hiroshima 733-0036 (JP)

(74) Representative: **Studio Torta S.p.A.**
Via Viotti, 9
10121 Torino (IT)

(56) References cited:
WO-A1-2010/052286 **WO-A1-2010/115871**
WO-A2-2008/068305 **JP-A- S5 418 466**
JP-A- H02 245 094 **JP-A- H07 257 903**
JP-A- 2000 086 211 **JP-A- 2000 248 286**
US-A1- 2012 010 306

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

Field

5 [0001] The present invention relates to a gas clean-up unit and a gas purification method, and for example, relates to a gas clean-up unit and a gas purification method that purify gas to be treated such as coal gasification gas.

Background

10 [0002] Conventionally, a gas clean-up unit including a COS converter that converts carbonyl sulfide in gas to be treated such as coal gasification gas to hydrogen sulfide, in the presence of a catalyst, has been developed (for example, see Patent Literature 1). In the COS converter of the gas clean-up unit, carbonyl sulfide contained in the coal gasification gas is hydrolyzed to hydrogen sulfide and carbon dioxide by the hydrolysis reaction represented by the following reaction formula (1).



Citation List

20 Patent Literature

[0003]

25 Patent Literature 1: Japanese Patent No. 4227676

Patent Literature 2 : US2012010306 describing a process for removing sulphur-containing, nitrogen-containing and halogen-containing impurities contained in a synthesis gas.

Abstract

30 Summary

Technical Problem

35 [0004] The hydrolysis reaction represented by the reaction formula (1) described above is a reversible reaction with heat generation. Consequently, a low temperature condition is advantageous for reducing carbonyl sulfide from the equilibrium constraint relation. However, when the reaction temperature for hydrolyzing carbonyl sulfide is too low, trace components contained in the coal gasification gas such as ammonia, halogen, and hydrocarbon may be deposited. Consequently, in the COS converter, carbonyl sulfide is hydrolyzed at a temperature condition higher than that at which 40 the trace components are deposited. However, when the concentration of carbonyl sulfide in the gas to be treated is high (for example, equal to or more than 1000 ppm), it is sometimes difficult to reduce the concentration of carbonyl sulfide to a desired concentration.

[0005] An object of the present invention is to provide a gas clean-up unit and a gas purification method that can effectively reduce the concentration of carbonyl sulfide in gas to be treated, even when the concentration of carbonyl sulfide in the gas to be treated is high.

Solution to Problem

50 [0006] A gas clean-up unit of the present invention comprises: a first conversion unit configured to perform a first conversion process of converting hydrogen cyanide contained in coal gasification gas to ammonia, and converting carbonyl sulfide contained therein to hydrogen sulfide in presence of a first catalyst and at a first predetermined temperature of equal to or higher than 240 degrees Celsius and equal to or lower than 350 degrees Celsius; a second conversion unit configured to perform a second conversion process of converting carbonyl sulfide remained in the gas 55 coal gasification gas that has been subjected to the first conversion process to hydrogen sulfide, in presence of a second catalyst and at a second predetermined temperature of equal to or higher than 150 degrees Celsius and equal to or lower than 240 degrees Celsius; a cleaning unit configured to perform a cleaning process of bringing the coal gasification gas into gas-liquid contact with cleaning liquid to remove ammonia, halogen and hydrocarbon traces by cleaning; and a desulfurization unit configured to absorb and remove hydrogen sulfide in the coal gasification gas by bringing the coal

gasification gas that has been subjected to the cleaning process into gas-liquid contact with absorbent, wherein the cleaning unit includes a first cleaning unit configured to perform a first cleaning process of bringing the coal gasification gas that has been subjected to the first conversion process into gas-liquid contact with cleaning liquid, and a second cleaning unit configured to perform a second cleaning process of bringing the coal gasification gas that has been subjected to the second conversion process into gas-liquid contact with cleaning liquid.

[0007] With this configuration, halogen, ammonia obtained through the first conversion process performed by the first conversion unit, and the like are removed by cleaning in the first cleaning process. Consequently, even when the gas to be treated is cooled to the first predetermined temperature or less, it is possible to prevent the deposition of trace components in the gas to be treated. Thus, not only the process on hydrogen cyanide contained in the gas to be treated will not be necessary, but it is also possible to hydrolyze carbonyl sulfide to hydrogen sulfide while cooling the gas to be treated after the first conversion process, to the second predetermined temperature that is suitable for converting carbonyl sulfide. Moreover, because carbonyl sulfide in the gas to be treated is converted to hydrogen sulfide in two steps of the first conversion process and the second conversion process, it is possible to effectively reduce the concentration of carbonyl sulfide in the gas to be treated to a desired concentration. Consequently, it is possible to implement the gas clean-up unit that can effectively reduce the concentration of carbonyl sulfide in the gas to be treated, even when the concentration of carbonyl sulfide in the gas to be treated is high.

[0008] It is possible to effectively prevent the deposition of trace components in the gas to be treated, and remove impurities contained in the gas to be treated after the second conversion process through the second cleaning process performed by the second cleaning unit.

[0009] The gas clean-up unit of the present invention preferably further includes a gasification unit configured to produce the gas to be treated containing carbonyl sulfide by gasifying a feedstock, and to supply the produced gas to be treated to the first conversion unit. With this configuration, the gas clean-up unit can effectively reduce carbonyl sulfide in the gas to be treated, even when the concentration of carbonyl sulfide in the gas to be treated obtained by gasifying a feedstock such as heavy oil and coal is high.

[0010] In the gas clean-up unit of the present invention, the first conversion unit converts carbonyl sulfide to hydrogen sulfide and converts hydrogen cyanide to ammonia. With this configuration, in the first conversion process, the first catalyst for decomposing hydrogen cyanide that selectively decomposes hydrogen cyanide can be used for carbonyl sulfide. Consequently, it is also possible to use the first catalyst different from the second catalyst that hydrolyzes carbonyl sulfide.

[0011] In the gas clean-up unit of the present invention, the first predetermined temperature is equal to or higher than 240 degrees Celsius and equal to or lower than 350 degrees Celsius. With this configuration, it is possible to further effectively prevent the deposition of trace components such as ammonia, halogen, and hydrocarbon contained in the coal gasification gas after the first conversion process.

[0012] In the gas clean-up unit of the present invention, the second predetermined temperature is equal to or higher than 150 degrees Celsius and equal to or lower than 240 degrees Celsius. With this configuration, it is possible to effectively convert carbonyl sulfide to hydrogen sulfide through the second conversion process.

[0013] A gas purification method of the present invention includes the steps of: performing a first conversion process of converting hydrogen cyanide contained in coal gasification gas to ammonia and converting carbonyl sulfide contained therein to hydrogen sulfide, in presence of a first catalyst and at a first predetermined temperature of equal to or higher than 240 degrees Celsius and equal to or lower than 350 degrees Celsius;

performing a second conversion process of converting carbonyl sulfide remained in the coal gasification gas that has been subjected to the first conversion process to hydrogen sulfide, in presence of a second catalyst and at a second predetermined temperature of equal to or higher than 150 degrees Celsius and equal to or lower than 240 degrees Celsius; bringing the coal gasification gas into gas-liquid contact with cleaning liquid to remove the ammonia by cleaning; and bringing the coal gasification gas from which ammonia is removed by cleaning into gas-liquid contact with absorbent to remove hydrogen sulfide in the coal gasification gas by absorbing,

wherein the step of cleaning includes the steps of

performing a first cleaning process of bringing the coal gasification gas that has been subjected to the first conversion process into gas-liquid contact with cleaning liquid to remove ammonia, halogen and hydrocarbon traces, and

performing a second cleaning process of bringing the coal gasification gas that has been subjected to the second conversion process into gas-liquid contact with cleaning liquid.

[0014] With this method, halogen, ammonia obtained through the first conversion process performed by the first conversion unit, and the like are removed by cleaning in the first cleaning process. Consequently, even when the gas to be treated is cooled to the first predetermined temperature or less, it is possible to prevent the deposition of trace components in the gas to be treated. Thus, not only the process on hydrogen cyanide will not be necessary, but it is also possible to perform the second conversion process of converting carbonyl sulfide to hydrogen sulfide, while cooling the gas to be treated to which the first conversion process is performed, to the second predetermined temperature that is suitable for converting carbonyl sulfide. Moreover, because carbonyl sulfide in the gas to be treated is converted to

hydrogen sulfide in two steps of the first conversion process and the second conversion process, it is possible to effectively reduce the concentration of carbonyl sulfide in the gas to be treated to a desired concentration. Consequently, it is possible to implement the gas purification method that can effectively reduce the concentration of carbonyl sulfide in the gas to be treated, even when the concentration of carbonyl sulfide in the gas to be treated is high.

5 [0015] With this method, the gas clean-up unit can remove ammonia and halogen in the gas to be treated after the first conversion process through the first cleaning process. Consequently, it is possible to effectively prevent the deposition of trace components in the gas to be treated, and remove impurities contained in the gas to be treated after the second conversion process through the second cleaning process.

10 [0016] The gas purification method of the present invention preferably further includes a step of producing the gas to be treated containing carbonyl sulfide by gasifying a feedstock. With this method, the gas clean-up unit can effectively reduce carbonyl sulfide in the gas to be treated, even when the concentration of carbonyl sulfide in the gas to be treated obtained by gasifying a feedstock such as heavy oil and coal is high.

Advantageous Effects of Invention

15 [0017] According to the present invention, it is possible to implement the gas clean-up unit and the gas purification method that can effectively reduce carbonyl sulfide in the gas to be treated, even when the concentration of carbonyl sulfide in the gas to be treated is high.

20 Brief Description of Drawings

[0018]

25 FIG. 1 is a schematic diagram illustrating an example of a gas clean-up unit according to a first embodiment of the present invention.

FIG. 2 is a schematic diagram illustrating another example of the gas clean-up unit according to the first embodiment of the present invention.

30 FIG. 3 is a schematic diagram illustrating another example of the gas clean-up unit according to the first embodiment of the present invention.

FIG. 4 is a schematic diagram illustrating an example of a gas clean-up unit according to a second embodiment of the present invention.

35 FIG. 5 is a schematic diagram illustrating another example of the gas clean-up unit according to the second embodiment of the present invention.

FIG. 6 is a schematic diagram illustrating another example of the gas clean-up unit according to the second embodiment of the present invention.

Description of Embodiments

40 [0019] The present inventors have focused on the fact that the carbonyl sulfide converter used in a conventional gas clean-up unit cannot effectively reduce the concentration of carbonyl sulfide in the gas to be treated containing high-concentration of carbonyl sulfide such as coal gasification gas. The present inventors have found out that even when the gas to be treated containing high-concentration of carbonyl sulfide is used, it is possible to reduce the concentration of carbonyl sulfide to a desired concentration, while preventing the deposition of trace components in the gas to be treated, by decomposing hydrogen cyanide contained in the gas to be treated, and by converting carbonyl sulfide to hydrogen sulfide at a temperature suitable for converting carbonyl sulfide. Thus, the present invention has been completed.

45 [0020] Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings. It is to be understood that the present invention is not limited to the following embodiments, and may be suitably modified.

50 First Embodiment

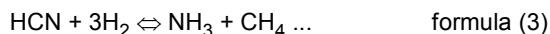
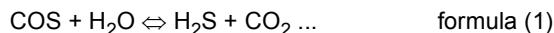
[0021] FIG. 1 is a schematic diagram illustrating an example of a gas clean-up unit 1 according to a first embodiment of the present invention.

55 [0022] As illustrated in FIG. 1, the gas clean-up unit 1 according to the present embodiment includes a gasifier (gasification unit) 11 to which a feedstock F and an oxygen containing gas O are fed, a first carbonyl sulfide converter (first conversion unit) 12 (hereinafter, referred as a "first COS converter 12") provided in the subsequent stage of the gasifier 11, a first cleaner (first cleaning unit) 13 provided in the subsequent stage of the first COS converter 12, a second

carbonyl sulfide converter (second conversion unit) 14 (hereinafter, referred as a "second COS converter 14") provided in the subsequent stage of the first cleaner 13, a second cleaner (second cleaning unit) 15 provided in the subsequent stage of the second COS converter 14, and a desulfurizer (desulfurization unit) 16 provided in the subsequent stage of the second cleaner 15. A gas turbine 17 is provided in the subsequent stage of the desulfurizer 16.

5 [0023] The gasifier 11 produces gasification gas (gas to be treated) G_1 containing carbonyl sulfide and hydrogen cyanide by gasifying the supplied feedstock F and oxygen containing gas O. Moreover, the gasifier 11 supplies the produced high-temperature gasification gas G_1 to the first COS converter 12. The feedstock F is not particularly limited as long as the feedstock F produces carbonyl sulfide as a byproduct, and for example, coal, heavy oil, or the like that has a high sulfur concentration is used. The gas clean-up unit 1 can effectively reduce the concentration of carbonyl sulfide even when coal containing a high proportion of sulfur component that produces a large amount of carbonyl sulfide is used, among the coal, heavy oil, or the like. The oxygen containing gas O is not particularly limited as long as the oxygen containing gas O is capable of oxidizing the feedstock, and for example, oxygen and the like may be used. The gasifier 11 is not necessarily required as long as the gasification gas G_1 can be supplied to the first COS converter 12.

10 [0024] In the presence of a first catalyst and at a first predetermined temperature, the first COS converter 12 performs a first conversion process of converting hydrogen cyanide contained in the gasification gas G_1 to ammonia as represented by the following reaction formula (1), and converting carbonyl sulfide to hydrogen sulfide as represented by the following reaction formula (2) and the following reaction formula (3). Moreover, the first COS converter 12 supplies gasification gas G_2 that contains ammonia and hydrogen sulfide produced by the first conversion process to the first cleaner 13. By performing the first conversion process as described above, it is possible to decompose carbonyl sulfide and hydrogen cyanide contained in the gasification gas G_1 . Consequently, it is possible to reduce the concentration of carbonyl sulfide in the gasification gas G_1 , and remove hydrogen cyanide therefrom.



30 [0025] The first catalyst is not particularly limited as long as the first catalyst can decompose hydrogen cyanide and carbonyl sulfide. The first catalyst may be a hydrolysis catalyst containing an active component that decomposes carbonyl sulfide and hydrogen cyanide, and a titanium oxide-based carrier that carries the active component, or the like.

35 [0026] For example, a component mainly composed of at least one type of metal selected from a group consisting of barium, nickel, ruthenium, cobalt, and molybdenum may be used as the active component. One type of metal may be used independently, or two or more types of metal may be used together. By using the metal as described above as the main component, it is possible to effectively decompose not only carbonyl sulfide but also hydrogen cyanide. For example, the amount of the active component to be carried is preferably between equal to or more than 0.1 mass% and equal to or less than 25 mass%, and more preferably between equal to or more than 1 mass% and equal to or less than 22 mass%.

40 [0027] For example, titanium oxide and composite oxide containing titanium oxide and the other oxide may be used as the titanium oxide-based carrier. By using the titanium oxide-based carrier such as the above, it is possible to fix the active component without fail. Moreover, because the titanium oxide-based carrier is chemically stable under the use conditions of the first catalyst, the function of the catalyst will not be blocked. It is preferable to use titanium oxide having an anatase type crystal structure that has a large specific surface area, as the titanium oxide. Consequently, the amount of the active component to be carried is increased, thereby improving the catalyst activity. For example, the composite oxide includes a titanium oxide-based composite oxide such as a composite oxide containing titanium oxide and silicon oxide, a composite oxide containing titanium oxide and aluminum oxide, a composite oxide containing titanium oxide and zirconium oxide, and the like. The composite ratio of titanium oxide and metal oxide to be combined is preferably within a range of 1:99 to 99:1, and more preferably within a range of 50:50 to 95:5. Consequently, because it is possible to increase the specific surface area that is an area for carrying the active component, it is possible to improve the catalyst performance of the first catalyst. By using the titanium oxide-based composite oxide as described above, the specific surface area of the first catalyst is increased, thereby improving the heat resistance. One type of the titanium oxide-based carrier may be used independently, or two or more types of titanium oxide-based carriers may be used together.

45 [0028] It is preferable to add at least one type of metal salt selected from a group consisting of barium carbonate, nickel carbonate, ruthenium nitrate, cobalt carbonate, and ammonium molybdate to the titanium oxide-based carrier as an additive. Because these additives are stable under the use conditions of the first catalyst, it is possible to use the first catalyst in a stable manner.

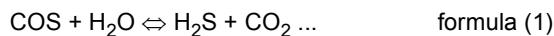
50 [0029] It is preferable that the first catalyst has a honeycomb shape. Thus, even in a use environment in which dust and the like coexist, it is possible to prevent clogging and pressure loss of the first catalyst. Consequently, it is possible

to keep the first catalyst in a highly active state.

[0030] The temperature range of the first predetermined temperature is preferably equal to or higher than 240 degrees Celsius and equal to or lower than 350 degrees Celsius, more preferably equal to or higher than 240 degrees Celsius and equal to or lower than 320 degrees Celsius, and furthermore preferably equal to or higher than 240 degrees Celsius and equal to or lower than 300 degrees Celsius. By setting the temperature range of the first predetermined temperature as described above, it is possible to sufficiently reduce hydrogen cyanide in the gasification gas G_1 after the first conversion process, and effectively decompose carbonyl sulfide to hydrogen sulfide.

[0031] The first cleaner 13 performs a first cleaning process of removing ammonium in the gasification gas G_2 by bringing the gasification gas G_2 to which the first conversion process is performed into gas-liquid contact with cleaning liquid, and cooling the gasification gas G_2 to a second predetermined temperature that is lower than the first predetermined temperature. The first cleaner 13 also supplies gasification gas G_3 after the first cleaning process to the second COS converter 14. The cleaning liquid is not particularly limited as long as the cleaning liquid can remove ammonium in the gasification gas G_2 by cleaning, and for example, various types of cleaning water and the like may be used. In the first cleaning process, not only ammonium in the gasification gas G_2 is removed by cleaning, but also the gasification gas G_2 is cooled (for example, equal to or higher than 120 degrees Celsius and equal to or lower than 140 degrees Celsius) by coming into contact with cleaning liquid. By performing the first cleaning process as described above, it is possible to remove ammonium from the gasification gas G_2 that will be a cause for the deposition of trace components in the gasification gas G_2 . It is also possible to cool the gasification gas G_2 to temperature suitable for hydrolyzing carbonyl sulfide performed in the second COS converter 14 in the subsequent stage. To effectively bring the temperature of the gasification gas G_2 after the first cleaning process to the second predetermined temperature, a heat exchanger that adjusts the temperature of the gasification gas G_2 to the second predetermined temperature may be provided between the first cleaner 13 and the second COS converter 14.

[0032] In the presence of the second catalyst and at the second predetermined temperature that is lower than the first predetermined temperature, the second COS converter 14 performs a second conversion process of converting carbonyl sulfide that still remains in the gasification gas G_3 to which the first cleaning process is performed to hydrogen sulfide, as represented by the following reaction formula (1). Moreover, the second COS converter 14 supplies gasification gas G_4 after the second conversion process to the second cleaner 15. In the second conversion process, because the gasification gas G_3 is cooled to a temperature suitable for hydrolyzing carbonyl sulfide by the first cleaning process, the chemical equilibrium of the following reaction formula (1), which is an exothermic reaction, becomes advantageous for the hydrolysis reaction of carbonyl sulfide. Consequently, it is possible to effectively reduce the concentration of carbonyl sulfide in the gasification gas G_3 .



[0033] The second catalyst is not particularly limited as long as the second catalyst can hydrolyze carbonyl sulfide. For example, a hydrolysis catalyst containing an active component that decomposes carbonyl sulfide and hydrogen cyanide, and a titanium oxide-based carrier that carries the active component, and the like may be used as the second catalyst. Moreover, the same catalyst as the first catalyst may be used as the second catalyst. Furthermore, a catalyst suitable for hydrolyzing carbonyl sulfide that is different from the first catalyst may also be used as the second catalyst. Still furthermore, a pellet-shaped catalyst may be used as the second catalyst.

[0034] The temperature range of the second predetermined temperature is preferably equal to or higher than 150 degrees Celsius and equal to or lower than 240 degrees Celsius, and more preferably equal to or higher than 180 degrees Celsius and equal to or lower than 200 degrees Celsius. By setting the temperature range of the second predetermined temperature as described above, the hydrolysis reaction of carbonyl sulfide proceeds quickly. Moreover, because the chemical equilibrium of the reaction formula (1) described above becomes advantageous for the hydrolysis reaction of carbonyl sulfide, it is possible to sufficiently reduce the concentration of carbonyl sulfide in the gasification gas G_3 after the second conversion process.

[0035] The second cleaner 15 performs a second cleaning process for removing ammonium and trace components in the gasification gas G_4 by bringing the gasification gas G_4 to which the second conversion process is performed into gas-liquid contact with cleaning liquid. By performing the second cleaning process, impurities in the gasification gas G_4 are removed by cleaning. Moreover, the second cleaner 15 supplies gasification gas G_5 after the second cleaning process to the desulfurizer 16. The cleaning liquid is not particularly limited as long as the cleaning liquid can remove hydrogen sulfide in the gasification gas G_4 by cleaning, and for example, various types of cleaning water and the like may be used.

[0036] The desulfurizer 16 absorbs and removes hydrogen sulfide contained in the gasification gas G_5 , by bringing the gasification gas G_5 to which the second cleaning process is performed into gas-liquid contact with cleaning liquid. Consequently, it is possible to obtain clean syngas G_6 from which hydrogen sulfide contained in the gasification gas G_5 is removed. The absorbent is not particularly limited as long as the absorbent can absorb hydrogen sulfide, and an

amine-based absorbent used for various desulfurization devices and the like is used. The desulfurizer 16 supplies the clean syngas G₆ from which hydrogen sulfide is removed to the gas turbine 17.

[0037] The gas turbine 17 generates power by burning the clean syngas G₆ supplied from the desulfurizer 16 with oxygen. Moreover, the gas turbine 17 discharges combustion flue gas G₇ generated by burning the clean syngas G₆ to the outside. It is to be noted that the clean syngas G₆ is also applicable for synthesizing various chemicals other than being a fuel for the gas turbine 17.

[0038] Next, the overall operation of the gas clean-up unit 1 will be described. The gasification gas G₁ that is produced by gasifying the feedstock F in the gasifier 11 is supplied to the first COS converter 12. In the first COS converter 12, the first conversion process is performed on the gasification gas G₁ at the first predetermined temperature (for example, equal to or higher than 240 degrees Celsius and equal to or lower than 350 degrees Celsius), and carbonyl sulfide is hydrolyzed to hydrogen sulfide. Moreover, hydrogen cyanide is decomposed into ammonia and removed from the gasification gas G₁, and the gasification gas G₁ is supplied to the first cleaner 13 as the gasification gas G₂. In the first cleaner 13, ammonia, halogen, and the like in the gasification gas G₂ are removed by cleaning through the first cleaning process of bringing the gasification gas G₂ into gas-liquid contact with cleaning liquid. Moreover, the gasification gas G₂ is cooled to the second predetermined temperature (for example, equal to or higher than 150 degrees Celsius and equal to or lower than 240 degrees Celsius), and is supplied to the second COS converter 14 as the gasification gas G₃. In this process, a heat exchanger may be used to heat the gasification gas G₂ after cleaning to equal to or higher than 150 degrees Celsius and equal to or lower than 240 degrees Celsius as required. In the second COS converter 14, carbonyl sulfide in the gasification gas G₃ is hydrolyzed by the second conversion process. The gasification gas G₃ is then supplied to the second cleaner 15 as the gasification gas G₄ the concentration of carbonyl sulfide of which is reduced to the predetermined concentration. In the second cleaner 15, impurities in the gasification gas G₄ are removed by the second cleaning process of bringing the gasification gas G₄ into gas-liquid contact with cleaning liquid, and the gasification gas G₄ is supplied to the desulfurizer 16 as the gasification gas G₅. In the desulfurizer 16, the gasification gas G₅ is supplied to the gas turbine 17 as the clean syngas G₆ from which hydrogen sulfide is removed, by bringing the gasification gas G₅ into gas-liquid contact with absorbent. In this process, the clean syngas G₆ from which hydrogen sulfide is removed by the desulfurizer 16 is supplied to the gas turbine 17. Consequently, it is possible to prevent the gas turbine 17 from being corroded by hydrogen sulfide. In the gas turbine 17, the clean syngas G₆ is burnt with oxygen, and is discharged as the combustion flue gas G₇.

[0039] In the gas clean-up unit 1 illustrated in FIG. 1, an example of providing two cleaners of the first cleaner 13 and the second cleaner 15 is described. However, the gas clean-up unit 1 may also include a single cleaner. FIG. 2 is a schematic diagram illustrating another example of the gas clean-up unit according to the present embodiment. As illustrated in FIG. 2, in a gas clean-up unit 2, a cleaner 18 is provided in the subsequent stage of the first COS converter 12, and the desulfurizer 16 is provided in the subsequent stage of the second COS converter 14. In other words, in the gas clean-up unit 2, the cleaner 18 is provided instead of the first cleaner 13 in the gas clean-up unit 1 illustrated in FIG. 1, and the second cleaner 15 is omitted therefrom. Moreover, a heat exchanger that adjusts the gasification gas G₂ to the second predetermined temperature may be provided between the first COS converter 12 and the cleaner 18. Because the other configurations of the gas clean-up unit 2 are the same as those of the gas clean-up unit 1 illustrated in FIG. 1, the descriptions thereof will be omitted.

[0040] In the gas clean-up unit 2, the first COS converter 12 supplies the gasification gas G₂ that is obtained by performing a first conversion process on the gasification gas G₁, to the cleaner 18. Similar to the first cleaner 13 described above, the cleaner 18 performs a cleaning process of bringing the gasification gas G₂ into gas-liquid contact with cleaning liquid, and cools the gasification gas G₂ to a second processing temperature. Consequently, halogen, ammonia that is the decomposition of hydrogen cyanide in the gasification gas G₂, and the like are removed by cleaning. Moreover, the cleaner 18 supplies the gasification gas G₃ after the cleaning process to the second COS converter 14. The second COS converter 14 performs a second conversion process on the gasification gas G₃ and reduces the concentration of carbonyl sulfide in the gasification gas G₃ to a predetermined concentration or less. Then, the second COS converter 14 supplies the gasification gas G₃ to the desulfurizer 16 as the gasification gas G₄. Even when the gas clean-up unit 2 is configured in this manner, because hydrogen cyanide in the gasification gas G₂ is removed by the cleaner 18, it is possible to prevent the deposition of trace components in the gasification gas G₂.

[0041] FIG. 3 is a schematic diagram illustrating another example of the gas clean-up unit according to the present embodiment. As illustrated in FIG. 3, in a gas clean-up unit 3, the second COS converter 14 is provided in the subsequent stage of the first COS converter 12, and the cleaner 18 is provided in the subsequent stage of the second COS converter 14. In other words, in the gas clean-up unit 3, the cleaner 18 is provided instead of the second cleaner 15 of the gas clean-up unit 1 illustrated in FIG. 1, and the first cleaner 13 is omitted therefrom. Moreover, a heat exchanger that adjusts the gasification gas G₂ to the second predetermined temperature may be provided between the first COS converter 12 and the second COS converter 14. Because the other configurations of the gas clean-up unit 3 are the same as those of the gas clean-up unit 1 illustrated in FIG. 1, the descriptions thereof will be omitted.

[0042] In the gas clean-up unit 3, the first COS converter 12 supplies the gasification gas G₂ that is obtained by

5 performing a first conversion process on the gasification gas G_1 , to the second COS converter 14. The second COS converter 14 performs a second conversion process on the gasification gas G_2 and reduces the concentration of carbonyl sulfide in the gasification gas G_2 to a predetermined concentration. Then, the second COS converter 14 supplies the gasification gas G_2 to the cleaner 18 as the gasification gas G_4 . Similar to the second cleaner 15 described above, the cleaner 18 performs a cleaning process of bringing the gasification gas G_4 into gas-liquid contact with cleaning liquid. Consequently, ammonia that is the decomposition of hydrogen cyanide, halogen, and the like in the gasification gas G_4 are removed by cleaning. Moreover, the cleaner 18 supplies the gasification gas G_5 after the cleaning process to the desulfurizer 16. Even when the gas clean-up unit 3 is configured in this manner, because hydrogen cyanide in the gasification gas G_4 is removed by the cleaner 18, it is possible to prevent the deposition of trace components in the gasification gas G_2 .

10 [0043] As described, with the embodiment described above, halogen, ammonia obtained through the first conversion process performed in the first COS converter 12, and the like are removed by cleaning in the first cleaning process. Consequently, even when the gasification gas G_2 is cooled to the first predetermined temperature or less, it is possible to prevent the deposition of trace components in the gasification gas G_2 . Thus, not only the process on hydrogen cyanide 15 will not be necessary, but it is also possible to perform the second conversion process of converting carbonyl sulfide to hydrogen sulfide, while cooling the gasification gas G_2 to which the first conversion process is performed to the second predetermined temperature that is equal to or lower than the first predetermined temperature and that is suitable for the second conversion process for carbonyl sulfide. Moreover, because carbonyl sulfide in the gasification gas G_1 is converted to hydrogen sulfide in two steps of the first conversion process and the second conversion process, it is possible to 20 effectively reduce the concentration of carbonyl sulfide in the gasification gas G_1 to a desired concentration. Consequently, it is possible to implement the gas clean-up units 1, 2, and 3 that can effectively reduce the concentration of carbonyl sulfide in the gasification gas G_1 , even when the concentration of carbonyl sulfide in the gasification gas G_1 is high.

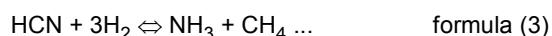
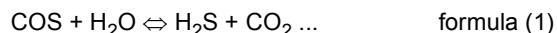
25 Second Embodiment

[0044] Next, a second embodiment of the present invention will be described. In the following embodiments, points different from those in the first embodiment described above will be mainly explained, and repeated explanation will be omitted. Moreover, the same reference numerals denote the same components as those in the first embodiment described above. Furthermore, the following embodiments can be implemented by a suitable combination.

30 [0045] FIG. 4 is a schematic diagram illustrating an example of a gas clean-up unit 4 according to a second embodiment of the present invention.

[0046] As illustrated in FIG. 4, the gas clean-up unit 4 according to the present embodiment includes the gasifier (gasification unit) 11 to which the feedstock F and the oxygen containing gas O are fed, a hydrogen cyanide converter 21 (hereinafter, referred to as an "HCN converter 21") provided in the subsequent stage of the gasifier 11, the first cleaner (first cleaning unit) 13 provided in the subsequent stage of the HCN converter 21, a carbonyl sulfide converter (second conversion unit) 22 (hereinafter, referred to as a "COS converter 22") provided in the subsequent stage of the first cleaner 13, the second cleaner (second cleaning unit) 15 provided in the subsequent stage of the COS converter 22, and the desulfurizer (desulfurization unit) 16 provided in the subsequent stage of the second cleaner (second cleaning unit) 15. In other words, in the gas clean-up unit 4, the HCN converter 21 is provided instead of the first COS converter 12 in the gas clean-up unit 1 illustrated in FIG. 1, and the COS converter 22 is provided instead of the second COS converter 14.

35 [0047] In the presence of the first catalyst and at the first predetermined temperature, the HCN converter 21 mainly performs a first conversion process of converting hydrogen cyanide contained in the gasification gas G_1 to ammonia, as represented by the following reaction formulae (2) and (3). In this example, not only the first conversion process for hydrogen cyanide is performed, but also a conversion process of converting carbonyl sulfide to hydrogen sulfide represented by the following formula (1) proceeds as a side reaction. Moreover, the HCN converter 21 also supplies gasification gas G_8 containing ammonia and a small amount of hydrogen sulfide produced by the first conversion process, to the first cleaner 13. By performing the first conversion process as described above, it is possible to decompose and remove 40 hydrogen cyanide contained in the gasification gas G_1 .



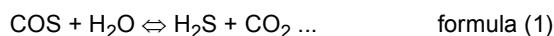
55 [0048] The first catalyst is not particularly limited as long as the first catalyst can decompose hydrogen cyanide, and a conventionally known catalyst for decomposing hydrogen cyanide may be used.

[0049] The temperature range of the first predetermined temperature is preferably equal to or higher than 240 degrees

Celsius and equal to or lower than 350 degrees Celsius, more preferably equal to or higher than 240 degrees Celsius and equal to or lower than 320 degrees Celsius, and furthermore preferably equal to or higher than 240 degrees Celsius and equal to or lower than 300 degrees Celsius. By setting the temperature range of the first predetermined temperature as described above, it is possible to sufficiently reduce hydrogen cyanide that still remains in the gasification gas G_8 after the first conversion process.

[0050] The first cleaner 13 performs a first cleaning process of removing ammonia in the gasification gas G_8 by bringing the gasification gas G_8 to which the first conversion process is performed into gas-liquid contact with cleaning liquid, and cooling the gasification gas G_8 . Moreover, the first cleaner 13 supplies the gasification gas G_3 after the first cleaning process to the COS converter 22. In the first cleaning process, not only ammonia in the gasification gas G_8 is removed by cleaning, but also the gasification gas G_8 is cooled (for example, equal to or higher than 100 degrees Celsius and equal to or lower than 200 degrees Celsius) by coming into contact with cleaning liquid. With the first cleaning process such as the above, it is possible to remove ammonia from the gasification gas G_8 that will be a cause for the deposition of the trace components in the gasification gas G_8 . Moreover, it is possible to cool the gasification gas G_8 to the temperature suitable for hydrolyzing carbonyl sulfide performed in the COS converter 22 in the subsequent stage. To effectively bring the temperature of the gasification gas G_3 after the first cleaning process to the second predetermined temperature, a heat exchanger that adjusts the temperature of the gasification gas G_3 to the second predetermined temperature may be provided between the first cleaner 13 and the COS converter 22.

[0051] In the presence of the second catalyst and at the second predetermined temperature that is lower than the first predetermined temperature, the COS converter 22 performs a second conversion process of converting carbonyl sulfide that still remains in the gasification gas G_3 to which the first cleaning process is performed, to hydrogen sulfide, as represented by the following reaction formula (1). Moreover, the COS converter 22 supplies gasification gas G_9 after the second conversion process to the second cleaner 15. In the second conversion process, because the gasification gas G_3 is cooled to a temperature suitable for hydrolyzing carbonyl sulfide by the first cleaning process, the chemical equilibrium of the following reaction formula (1), which is an exothermic reaction, becomes advantageous for the hydrolysis reaction of carbonyl sulfide. Consequently, it is possible to effectively reduce the concentration of carbonyl sulfide in the gasification gas G_3 .



[0052] The second catalyst is not particularly limited as long as the second catalyst can hydrolyze carbonyl sulfide, and for example, the same catalyst as the first catalyst according to the first embodiment described above and the like may be used. Moreover, a catalyst suitable for hydrolyzing carbonyl sulfide that is different from the first catalyst may also be used as the second catalyst. Furthermore, a pellet-shaped catalyst may be used as the second catalyst.

[0053] The temperature range of the second predetermined temperature is preferably equal to or higher than 150 degrees Celsius and equal to or lower than 240 degrees Celsius, and more preferably equal to or higher than 180 degrees Celsius and equal to or lower than 210 degrees Celsius. By setting the temperature range of the second predetermined temperature as described above, the hydrolysis reaction of carbonyl sulfide proceeds quickly. Moreover, because the chemical equilibrium of the reaction formula (1) described above becomes advantageous for the hydrolysis reaction of carbonyl sulfide, it is possible to sufficiently reduce the concentration of carbonyl sulfide in the gasification gas G_9 after the second conversion process.

[0054] The second cleaner 15 performs a second cleaning process for removing hydrogen sulfide in the gasification gas G_9 by bringing the gasification gas G_9 to which the second conversion process is performed into gas-liquid contact with cleaning liquid. By performing the second cleaning process, impurities in the gasification gas G_9 are removed by cleaning. Moreover, the second cleaner 15 supplies the gasification gas G_5 after the second cleaning process to the desulfurizer 16. Because the other configurations are the same as those of the gas clean-up unit 1 illustrated in FIG. 1, the descriptions thereof will be omitted.

[0055] Next, the overall operation of the gas clean-up unit 4 will be described. The gasification gas G_1 that is produced by gasifying the feedstock F in the gasifier 11 is supplied to the HCN converter 21. In the HCN converter 21, the first conversion process is performed on the gasification gas G_1 at the first predetermined temperature (for example, equal to or higher than 240 degrees Celsius and equal to or lower than 350 degrees Celsius). Moreover, hydrogen cyanide is decomposed into ammonia and removed from the gasification gas G_1 , and the gasification gas G_1 is supplied to the first cleaner 13 as the gasification gas G_8 . In the first cleaner 13, ammonia, halogen, and the like in the gasification gas G_8 are removed by cleaning through the first cleaning process of bringing the gasification gas G_8 into gas-liquid contact with cleaning liquid. Moreover, the gasification gas G_8 is cooled to the second predetermined temperature (for example, equal to or higher than 150 degrees Celsius and equal to or lower than 240 degrees Celsius), and is supplied to the COS converter 22 as the gasification gas G_3 . In the COS converter 22, carbonyl sulfide in the gasification gas G_3 is hydrolyzed by the second conversion process, and the concentration of carbonyl sulfide is reduced to the predetermined concentration. Then, the gasification gas G_3 is supplied to the second cleaner 15 as the gasification gas G_9 . In the

second cleaner 15, impurities in the gasification gas G_9 are removed by the second cleaning process of bringing the gasification gas G_9 into gas-liquid contact with cleaning liquid. Then, the gasification gas G_9 is supplied to the desulfurizer 16 as the gasification gas G_5 . In the desulfurizer 16, the gasification gas G_5 is supplied to the gas turbine 17 as the clean syngas G_6 from which hydrogen sulfide is removed, by bringing the gasification gas G_5 into gas-liquid contact with absorbent. In the gas turbine 17, the clean syngas G_6 is burnt with oxygen and is discharged as combustion flue gas G_7 .

[0056] In the gas clean-up unit 4 illustrated in FIG. 4, an example of providing two cleaners of the first cleaner 13 and the second cleaner 15 is described. However, the gas clean-up unit 4 may also include a single cleaner. FIG. 5 is a schematic diagram illustrating another example of the gas clean-up unit according to the present embodiment. As illustrated in FIG. 5, in a gas clean-up unit 5, the cleaner 18 is provided in the subsequent stage of the HCN converter 21, and the desulfurizer 16 is provided in the subsequent stage of the COS converter 22. In other words, in the gas clean-up unit 5, the cleaner 18 is provided instead of the first cleaner 13 in the gas clean-up unit 4 illustrated in FIG. 4, and the second cleaner 15 is omitted therefrom. Moreover, a heat exchanger that adjusts the gasification gas G_8 to the predetermined temperature may be provided between the HCN converter 21 and the cleaner 18. Because the other configurations are the same as those of the gas clean-up unit 4 illustrated in FIG. 4, the descriptions thereof will be omitted.

[0057] In the gas clean-up unit 5, the HCN converter 21 supplies the gasification gas G_8 obtained by performing a first conversion process on the gasification gas G_1 at the first predetermined temperature, to the cleaner 18. Similar to the first cleaner 13 described above, the cleaner 18 performs a cleaning process of bringing the gasification gas G_8 into gas-liquid contact with cleaning liquid, and cools the gasification gas G_8 to the second processing temperature. Consequently, ammonia that is the decomposition of hydrogen cyanide, halogen, and the like in the gasification gas G_8 are removed by cleaning. Moreover, the cleaner 18 supplies the gasification gas G_3 after the cleaning process to the COS converter 22. The COS converter 22 performs a second conversion process on the gasification gas G_3 at the second predetermined temperature, and supplies the gasification gas G_3 to the desulfurizer 16 as the gasification gas G_9 . Even when the gas clean-up unit 5 is configured in this manner, because ammonia in the gasification gas G_8 is removed by the cleaner 18, it is possible to prevent the deposition of trace components in the gasification gas G_8 .

[0058] FIG. 6 is a schematic diagram illustrating another example of the gas clean-up unit according to the present embodiment. As illustrated in FIG. 6, in a gas clean-up unit 6, the COS converter 22 is provided in the subsequent stage of the HCN converter 21, and the cleaner 18 is provided in the subsequent stage of the COS converter 22. In other words, in the gas clean-up unit 6, the cleaner 18 is provided instead of the second cleaner 15 of the gas clean-up unit 4 illustrated in FIG. 4, and the first cleaner 13 is omitted therefrom. Moreover, a heat exchanger that adjusts the gasification gas G_8 to the predetermined temperature may be provided between the HCN converter 21 and the COS converter 22. Because the other configurations are the same as those of the gas clean-up unit 4 illustrated in FIG. 4, the descriptions thereof will be omitted.

[0059] In the gas clean-up unit 6, the HCN converter 21 supplies the gasification gas G_8 obtained by performing a first conversion process on the gasification gas G_1 at the first predetermined temperature, to the COS converter 22. The COS converter 22 performs a second conversion process on the gasification gas G_8 at the second predetermined temperature, and supplies the gasification gas G_8 to the cleaner 18 as the gasification gas G_9 . Similar to the second cleaner 15 described above, the cleaner 18 performs a cleaning process of bringing the gasification gas G_9 into gas-liquid contact with cleaning liquid. Consequently, halogen, ammonia that is the decomposition of hydrogen cyanide, and the like in the gasification gas G_8 are removed by cleaning. Moreover, the cleaner 18 supplies the gasification gas G_5 after the cleaning process to the desulfurizer 16. Even when the gas clean-up unit 6 is configured in this manner, because hydrogen cyanide in the gasification gas G_9 is removed by the cleaner 18, it is possible to prevent the deposition of trace components in the gasification gas G_8 .

[0060] As described above, with the embodiment described above, halogen, ammonia obtained through the first conversion process performed by the HCN converter 21, and the like are removed by cleaning through the first cleaning process. Consequently, it is possible to prevent the deposition of trace components in the gasification gas G_8 even when the gasification gas G_8 is cooled to equal to or lower than the first predetermined temperature. Thus, not only the process on hydrogen cyanide will not be necessary, but it is also possible to perform the second conversion process of converting carbonyl sulfide to hydrogen sulfide, while cooling the gasification gas G_8 to which the first conversion process is performed, to the second predetermined temperature that is equal to or lower than the first predetermined temperature and that is suitable for the second conversion process for carbonyl sulfide. Moreover, in the first conversion process, the first catalyst that selectively decomposes hydrogen cyanide can be used for carbonyl sulfide. Consequently, it is possible to use the first catalyst different from the second catalyst that hydrolyzes carbonyl sulfide. Moreover, it is possible to reduce the use amount of the second catalyst required for hydrolyzing carbonyl sulfide. Thus, it is possible to implement the gas clean-up units 4, 5, and 6 that can effectively reduce the concentration of carbonyl sulfide in the gasification gas G_1 , even when the concentration of carbonyl sulfide in the gasification gas G_1 is high.

Reference Signs List

[0061]

5	1, 2, 3, 4, 5, 6	Gas clean-up unit
11	11	Gasifier
12	12	First COS converter
13	13	First cleaner
14	14	Second COS converter
10	15	Second cleaner
16	16	Desulfurizer
17	17	Gas turbine
21	21	HCN converter
22	22	COS converter
15	F	Feedstock
	G ₁ , G ₂ , G ₃ , G ₄ , G ₅ , G ₈ , G ₉	Gasification gas
	G ₆	Clean syngas
	G ₇	Combustion flue gas
20	O	Oxygen containing gas

Claims

1. A gas clean-up unit, comprising:

25 a first conversion unit (12) configured to perform a first conversion process of converting hydrogen cyanide contained in coal gasification gas to ammonia, and converting carbonyl sulfide contained therein to hydrogen sulfide in presence of a first catalyst and at a first predetermined temperature of equal to or higher than 240 degrees Celsius and equal to or lower than 350 degrees Celsius;

30 a second conversion unit (14) configured to perform a second conversion process of converting carbonyl sulfide remained in the gas coal gasification gas that has been subjected to the first conversion process to hydrogen sulfide, in presence of a second catalyst and at a second predetermined temperature of equal to or higher than 150 degrees Celsius and equal to or lower than 240 degrees Celsius;

35 a cleaning unit (13, 15) configured to perform a cleaning process of bringing the coal gasification gas into gas-liquid contact with cleaning liquid to remove ammonia, halogen and hydrocarbon traces by cleaning; and a desulfurization unit (16) configured to absorb and remove hydrogen sulfide in the coal gasification gas by bringing the coal gasification gas that has been subjected to the cleaning process into gas-liquid contact with absorbent,

40 wherein the cleaning unit includes a first cleaning unit (13) configured to perform a first cleaning process of bringing the coal gasification gas that has been subjected to the first conversion process into gas-liquid contact with cleaning liquid, and a second cleaning unit (15) configured to perform a second cleaning process of bringing the coal gasification gas that has been subjected to the second conversion process into gas-liquid contact with cleaning liquid.

45 2. The gas clean-up unit according to claim 1, further comprising a gasification unit (11) configured to produce the coal gasification gas containing carbonyl sulfide by gasifying a feedstock, and to supply the produced coal gasification gas to the first conversion unit (12).

50 3. The gas clean-up unit according to claim 1 or 2, wherein the first conversion unit (12) converts carbonyl sulfide to hydrogen sulfide and converts hydrogen cyanide to ammonia.

4. A gas purification method, comprising the steps of:

55 performing a first conversion process of converting hydrogen cyanide contained in coal gasification gas to ammonia and converting carbonyl sulfide contained therein to hydrogen sulfide, in presence of a first catalyst and at a first predetermined temperature of equal to or higher than 240 degrees Celsius and equal to or lower than 350 degrees Celsius;

performing a second conversion process of converting carbonyl sulfide remained in the coal gasification gas

that has been subjected to the first conversion process to hydrogen sulfide, in presence of a second catalyst and at a second predetermined temperature of equal to or higher than 150 degrees Celsius and equal to or lower than 240 degrees Celsius;

5 bringing the coal gasification gas into gas-liquid contact with cleaning liquid to remove the ammonia by cleaning; and

bringing the coal gasification gas from which ammonia is removed by cleaning into gas-liquid contact with absorbent to remove hydrogen sulfide in the coal gasification gas by absorbing,

wherein the step of cleaning includes the steps of

10 performing a first cleaning process of bringing the coal gasification gas that has been subjected to the first conversion process into gas-liquid contact with cleaning liquid to remove ammonia, halogen and hydrocarbon traces, and

15 performing a second cleaning process of bringing the coal gasification gas that has been subjected to the second conversion process into gas-liquid contact with cleaning liquid.

15 5. The gas purification method according to claim 4, further comprising a step of producing the coal gasification gas containing carbonyl sulfide by gasifying a feedstock.

Patentansprüche

20 1. Gas-Reinigungseinheit, umfassend:

eine erste Umwandlungseinheit (12), die dazu eingerichtet ist, einen ersten Umwandlungsprozess auszuführen zum Umwandeln von in Kohlevergasungsgas enthaltener Blausäure in Ammoniak und zum Umwandeln von darin enthaltenem Carbonylsulfid in Schwefelwasserstoff in Anwesenheit eines ersten Katalysators und bei einer ersten vorbestimmten Temperatur von 240°C oder mehr und von 350 °C oder weniger;

25 eine zweite Umwandlungseinheit (14), die dazu eingerichtet ist, einen zweiten Umwandlungsprozess auszuführen zum Umwandeln von in dem Kohlevergasungsgas, das dem ersten Umwandlungsprozess unterzogen wurde, verbliebenem Carbonylsulfid in Schwefelwasserstoff in Anwesenheit eines zweiten Katalysators und bei einer zweiten vorbestimmten Temperatur von 150°C oder höher und 240°C oder weniger;

30 eine Reinigungseinheit (13, 15), die dazu eingerichtet ist, einen Reinigungsprozess auszuführen, um das Kohlevergasungsgas in Gas-Flüssigkeits-Kontakt mit einer Reinigungsflüssigkeit zu bringen, um Spuren von Ammoniak, Halogen und Kohlenwasserstoff durch Reinigen zu entfernen; und

35 eine Entschwefelungseinheit (16), die dazu eingerichtet ist, Schwefelwasserstoffe in dem Kohlevergasungsgas zu absorbieren und zu entfernen indem sie das Kohlevergasungsgas, das dem Reinigungsprozess unterzogen wurde, in Gas-Flüssigkeits-Kontakt mit einem Absorptionsmittel bringt,

40 wobei die Reinigungseinheit eine erste Reinigungseinheit (13) beinhaltet, die dazu eingerichtet ist, einen ersten Reinigungsprozess auszuführen, um das Kohlevergasungsgas, das dem ersten Umwandlungsprozess unterzogen wurde, in Gas-Flüssigkeits-Kontakt mit der Reinigungsflüssigkeit zu bringen, und eine zweite Reinigungseinheit (15), die dazu eingerichtet ist, einen zweiten Reinigungsprozess auszuführen, um das Kohlevergasungsgas, das dem zweiten Umwandlungsprozess unterzogen wurde, in Gas-Flüssigkeits-Kontakt mit der Reinigungsflüssigkeit zu bringen.

45 2. Gas-Reinigungseinheit nach Anspruch 1, weiterhin umfassend eine Vergasungseinheit (11), die dazu eingerichtet ist, das Kohlevergasungsgas, das Carbonylsulfid enthält, durch Vergasen eines Ausgangsmaterials zu erzeugen und das erzeugte Kohlevergasungsgas der ersten Umwandlungseinheit (12) zuzuführen.

50 3. Gas-Reinigungseinheit nach Anspruch 1 oder 2, wobei die erste Umwandlungseinheit (12) Carbonylsulfid in Schwefelwasserstoff und Blausäure in Ammoniak umwandelt.

4. Gas-Reinigungsverfahren, umfassend die folgenden Schritte:

Ausführen eines ersten Umwandlungsprozesses zum Umwandeln von in Kohlevergasungsgas enthaltener Blausäure in Ammoniak und Umwandeln von darin enthaltenem Carbonylsulfid in Schwefelwasserstoff in Anwesenheit eines ersten Katalysators und bei einer ersten vorbestimmten Temperatur von 240°C oder mehr und 350°C oder weniger;

55 Ausführen eines zweiten Umwandlungsprozesses zum Umwandeln von in dem Kohlevergasungsgas, das dem ersten Umwandlungsprozess unterzogen wurde, zurückgebliebenem Carbonylsulfid in Schwefelwasserstoff in

Anwesenheit eines zweiten Katalysators und bei einer zweiten vorbestimmten Temperatur von 150°C oder mehr und 240°C oder weniger;

Herstellen eines Gas-Flüssigkeits-Kontaktes des Kohlevergasungsgases mit Reinigungsflüssigkeit, um das Ammoniak durch Reinigen zu entfernen; und

5 Herstellen eines Gas-Flüssigkeits-Kontaktes des Kohlevergasungsgases, von welchem Ammoniak durch Reinigen entfernt wird, mit einem Absorptionsmittel, um Schwefelwasserstoff in dem Kohlevergasungsgas durch Absorption zu entfernen,

wobei der Reinigungsschritt die folgenden Schritte beinhaltet:

10 Ausführen eines ersten Reinigungsprozesses, bei dem das Kohlevergasungsgas, das dem ersten Umwandlungsprozess unterzogen wurde, in Gas-Flüssigkeits-Kontakt mit Reinigungsflüssigkeit gebracht wird, um Spuren von Ammoniak, Halogen und Kohlenwasserstoff zu entfernen, und

15 Ausführen eines zweiten Reinigungsprozesses, bei dem das Kohlevergasungsgas, das dem zweiten Umwandlungsprozess unterzogen wurde, in Gas-Flüssigkeits-Kontakt mit der Reinigungsflüssigkeit gebracht wird.

5. Gas-Reinigungsverfahren nach Anspruch 4, weiterhin umfassend einen Schritt des Erzeugens des Kohlevergasungsgases, das Carbonylsulfid aufweist, durch Vergasen eines Ausgangsmaterials.

20

Revendications

1. Unité d'épuration de gaz, comprenant :

25 une première unité de conversion (12) conçue pour effectuer un premier processus de conversion consistant à convertir en ammoniac le cyanure d'hydrogène contenu dans le gaz issu de la gazéification du charbon et à convertir le sulfure de carbonyle contenu à l'intérieur en sulfure d'hydrogène en présence d'un premier catalyseur et à une première température prédéfinie supérieure ou égale à 240 degrés Celsius et inférieure ou égale à 350 degrés Celsius ;

30 une seconde unité de conversion (14) conçue pour effectuer un second processus de conversion consistant à convertir le sulfure de carbonyle resté dans le gaz issu de la gazéification du charbon qui a été soumis au premier processus de conversion en sulfure d'hydrogène, en présence d'un second catalyseur et à au moins une seconde température prédéfinie supérieure ou égale à 150 degrés Celsius et inférieure ou égale à 240 degrés Celsius ;

35 une unité de nettoyage (13, 15) conçue pour effectuer un processus de nettoyage consistant à amener le gaz issu de la gazéification du charbon en contact gaz-liquide avec un liquide de nettoyage pour éliminer par nettoyage les traces d'ammoniac, d'halogène et d'hydrocarbure ; et

40 une unité de désulfuration (16) conçue pour absorber et éliminer le sulfure d'hydrogène dans le gaz issu de la gazéification du charbon en amenant le gaz issu de la gazéification du charbon, qui a été soumis au processus de nettoyage, en contact gaz-liquide avec un absorbant,

45 dans laquelle l'unité de nettoyage comprend une première unité de nettoyage (13) conçue pour effectuer un premier processus de nettoyage consistant à amener le gaz issu de la gazéification du charbon, qui a été soumis au premier processus de conversion, en contact gaz-liquide avec un liquide de nettoyage, et une seconde unité de nettoyage (15) conçue pour effectuer un second processus de nettoyage consistant à amener le gaz issu de la gazéification du charbon, qui a été soumis au second processus de conversion, en contact gaz-liquide avec le liquide de nettoyage.

50 2. Unité d'épuration de gaz selon la revendication 1, comprenant en outre une unité de gazéification (11) conçue pour produire le gaz issu de la gazéification du charbon contenant du sulfure de carbonyle en gazéifiant une matière première et pour acheminer le gaz issu de la gazéification du charbon vers la première unité de conversion (12).

55 3. Unité d'épuration de gaz selon la revendication 1 ou 2, dans laquelle la première unité de conversion (12) convertit le sulfure de carbonyle en sulfure d'hydrogène et convertit le cyanure d'hydrogène en ammoniac.

4. Procédé de purification de gaz comprenant les étapes consistant à :

effectuer un premier processus de conversion consistant à convertir en ammoniac le cyanure d'hydrogène contenu dans le gaz issu de la gazéification du charbon et à convertir le sulfure de carbonyle contenu à l'intérieur

en sulfure d'hydrogène, en présence d'un premier catalyseur et à une première température prédéfinie supérieure ou égale à 240 degrés Celsius et inférieure ou égale à 350 degrés Celsius ;
effectuer un second processus de conversion consistant à convertir en sulfure d'hydrogène le sulfure de carbonyle resté dans le gaz issu de la gazéification du charbon qui a été soumis au premier processus de conversion, en présence d'un second catalyseur et à une seconde température prédéfinie supérieure ou égale à 150 degrés Celsius et inférieure ou égale à 240 degrés Celsius ;
amener le gaz issu de la gazéification du charbon en contact gaz-liquide avec le liquide de nettoyage pour éliminer l'ammoniac par nettoyage ; et
amener le gaz issu de la gazéification du charbon, duquel est éliminé l'ammoniac par nettoyage, en contact gaz-liquide avec un absorbant pour éliminer par absorption le sulfure d'hydrogène dans le gaz issu de la gazéification du charbon,
dans lequel l'étape de nettoyage comprend les étapes consistant à :

effectuer un premier processus de nettoyage consistant à amener le gaz issu de la gazéification du charbon, qui a été soumis au premier processus de conversion, en contact gaz-liquide avec le liquide de nettoyage afin d'éliminer les traces d'ammoniac, d'halogène et d'hydrocarbure, et
effectuer un second processus de nettoyage consistant à amener le gaz issu de la gazéification du charbon, qui a été soumis au second processus de conversion, en contact gaz-liquide avec le liquide de nettoyage.

20 5. Procédé de purification de gaz selon la revendication 4, comprenant en outre une étape consistant à produire le gaz issu de la gazéification du charbon contenant du sulfure de carbonyle par gazéification d'une matière première.

25

30

35

40

45

50

55

FIG.1

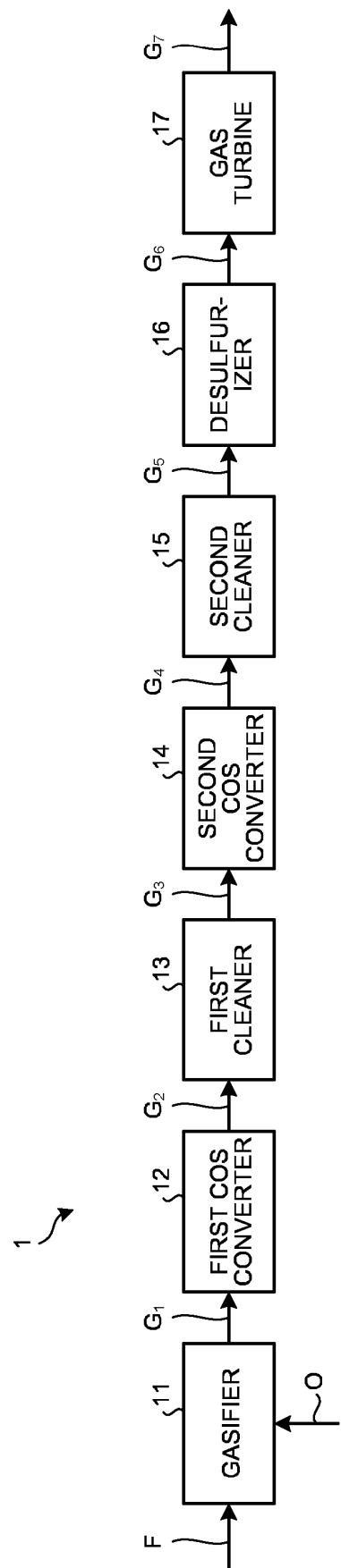


FIG.2

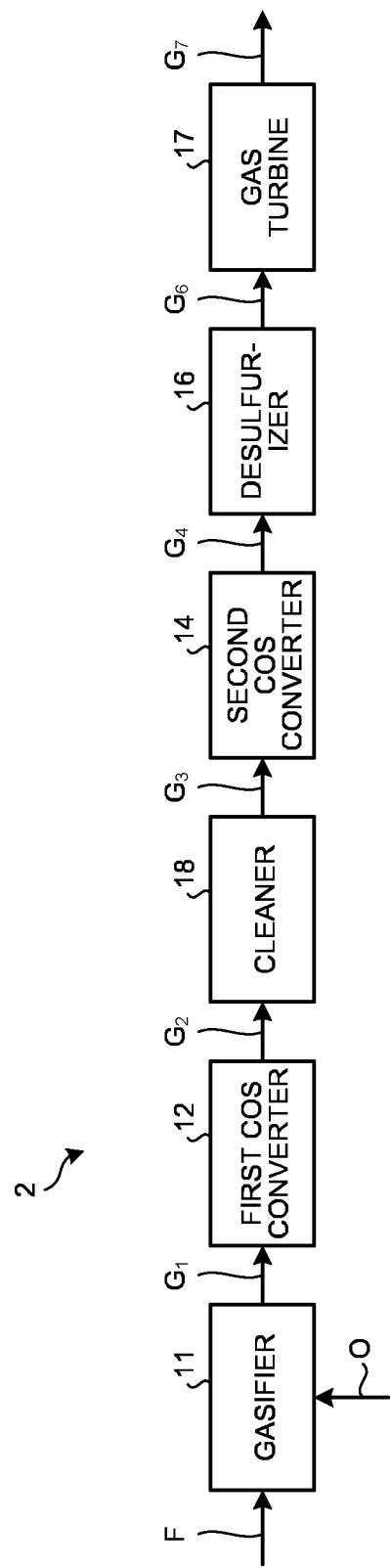


FIG.3

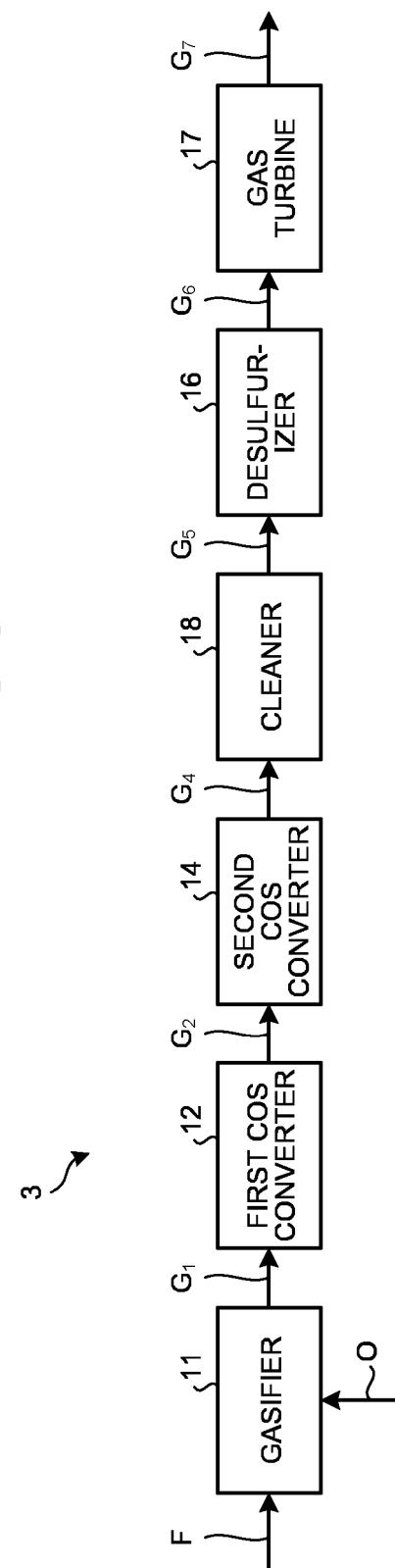


FIG.4

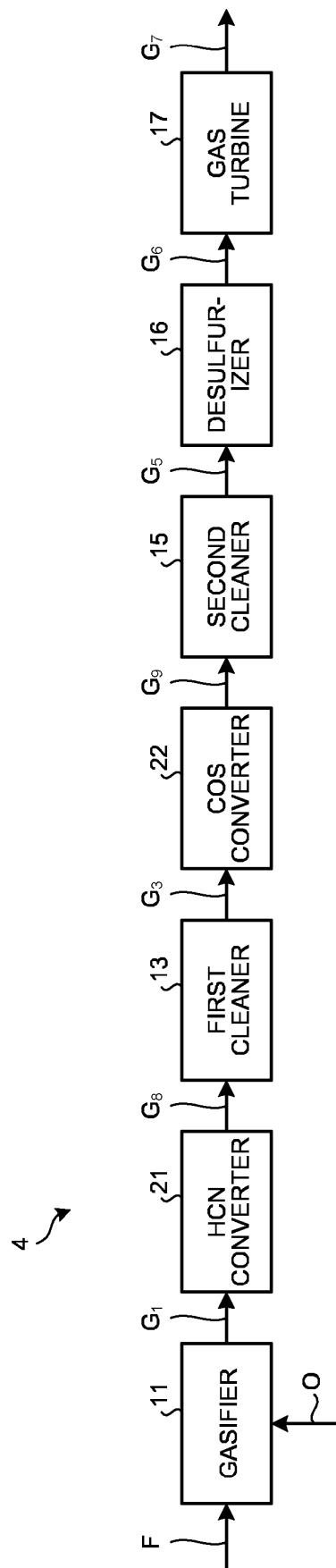


FIG.5

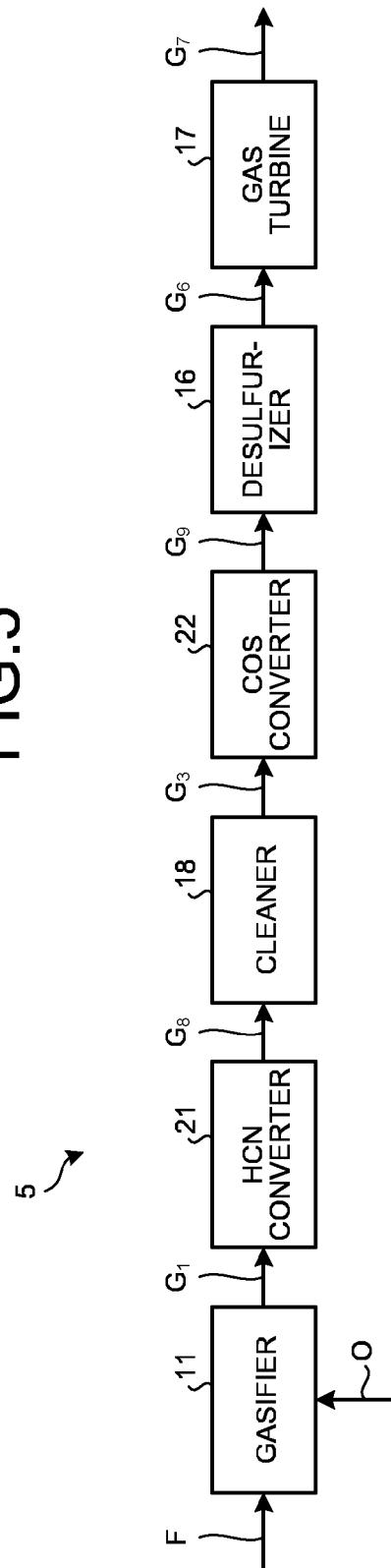
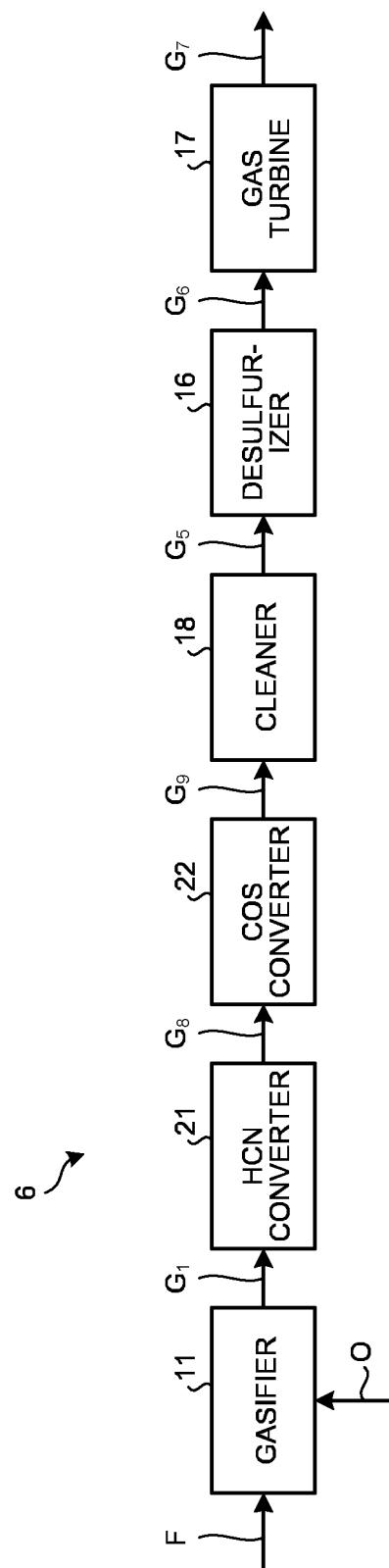


FIG.6



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 4227676 B [0003]
- US 2012010306 A [0003]